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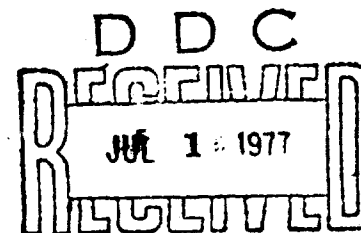
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March 1977

# Strategic Mobility Alternatives for the 1980s: Vol. 1, Executive Summary (U)

W. E. Hoehn, Jr., R. L. Perry, J. R. Gebman  
with A. A. Barbour, J. H. Hayes,  
J. W. Higgins, W. R. Micks, and P. C. Paris

A Project AIR FORCE report  
prepared for the  
United States Air Force



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(U) <sup>47</sup>Discusses optional ways of enhancing present and future strategic airlift forces. Airlift options being considered by the Air Force, critical uncertainties (including the appropriate mix of outsize and oversize capacity), and an incremental strategy for assessing future commitments are outlined. The authors recommend further analysis of C-5A wing problems, accelerated acquisition of spares to support higher surge ratios, resolution of some persistent CRAF difficulties, and a prompt start on work needed to support the procurement of additional outsize airlift capacity. Other important issues extend to: exploring, with the Army, ways to reduce airlift equipment lists and the feasibility of partial prepositioning of heavy but low cost items; (2) clarifying uncertainties in the C-141A stretch program; <sup>on</sup>(3) the implications of increasing crew utilization rates. The goal of such initiatives is to give the Air Force a better base for evaluating long term airlift enhancement needs and opportunities. (Author)

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PREFACE

This report and its companion volumes<sup>1</sup> document research conducted under Project AIR FORCE (formerly Project RAND) on alternative strategic mobility forces and their contribution to the deterrence of nonnuclear conflicts involving NATO. The reports draw upon earlier research at the Rand Corporation on the importance of capabilities for early, rapid reinforcement of NATO's ground forces posture; on the role of tactical airpower, prepositioning, and sea lane defense in enhancing NATO's defensive capabilities; and on cost and capability tradeoffs to achieve the desired enhancement. Previous research emphasized rapid deployment to the NATO theater of U.S. ground forces as an indispensable element of enhanced defenses and demonstrated that only strategic airlift can provide the critical element of *timeliness* under many likely scenarios. These reports, accordingly, focus on the analysis of options for enhancing strategic airlift capabilities to greatly increase the rate at which Army units can be moved to the European theater by air following a mobilization decision.

Earlier publications on this subject examined in some detail the constitution and classification by size and weight of Army unit equipment to be moved and evaluated the cost effectiveness of various airlift enhancement options. Early in 1975, the project leader for the study effort left Rand, during the initial drafting of a summary report. The main author of the present report became the interim project leader. In his capacity (then) as Deputy Vice President for Project RAND, he had previously reviewed preliminary research results from two studies, in other areas of the Project RAND research program, that bore on airlift issues. One study evaluated a series of possible aerodynamic and engine modifications or retrofits to conserve aircraft fuels and reduce the annual Air Force fuel bill. Included in that evaluation were several modifications of the C-141A. The second study (undertaken at the request of the Air Force) evaluated the applicability of a Rand-conceived procurement technique--directed licensing--to

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<sup>1</sup>*Executive Summary*, R-1941/1-AF (this volume); *Analysis and Conclusions*, R-1941/2-AF; and *Technical Appendixes*, R-1941/3-AF.

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the prospective purchase of a new wing for the C-5A fleet. Neither issue has been treated earlier under the strategic mobility project.

Rand management unilaterally decided to undertake an intensive two-month exploration of some implications of the C-5A rewing and the C-141A stretch decisions for the long-term strategic mobility enhancement problem. The findings of that research, which went beyond the research program outlined for the Air Staff project monitor (OPR), were briefed to a selected set of Air Staff general officers in April 1975. Those findings were in many respects at variance with the Air Staff's position of that time on a program for airlift enhancement. Further, Rand's research had used unofficial or estimated values for several parameters in the analysis, and the briefing proposed measures of merit different from those underlying earlier Air Force studies. Therefore, the Air Force Airlift Enhancement Working Group was reconvened during May and June 1975 to review the Rand research methods, provide "official" inputs, and assess the major points of agreement and disagreement between Air Force positions and Rand views. After receiving new data inputs, but while clarification and definition of several points were pending, the Air Staff asked Rand to prepare a written report.

A preliminary draft was circulated within the Air Staff at the working level in the spring of 1976; comments received were reflected in a "for-comment" draft circulated in the late summer of 1976 to major Air Force commands and organizations with responsibilities for strategic airlift. A further series of technical discussions were held during the fall of 1976, leading to these final reports.

This work has been carried out under the original project, entitled "Strategic Mobility." Of necessity, the OPR has remained the same, but that office is in no sense responsible for the directions the study has taken during the past year. The reports represent the general state of knowledge as of late 1976. As effort has been made to footnote more recent information, changes of Air Force policy or emphasis, and new schedules.

The analysis of these sections has benefited from discussion and review of preliminary drafts with representatives of the C-5A Systems

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Project Office and the Aeronautical Systems Division of AFSC, as well as with Headquarters, Military Airlift Command. This should not be interpreted as suggesting endorsement by those organizations of the findings and conclusions herein.

Controversy has occasionally attended the research and interim reports of findings. Nevertheless, these reports should help the Air Force identify and assess alternative courses of action to evaluate options for enhancing strategic airlift capabilities over the next 25 years.

Recent Project RAND publications on airlift issues include:

Hayes, J. H., and L. Cutler, *The Army Deployment Simulator with a Data Base of Army Units and Equipment*, R-1893-PR, September 1976.

Hayes, J. H., *Future Army Deployment Requirements* (U), R-1673-PR, April 1975 (Confidential).

Carter, G. A., *Directed Licensing: An Evaluation of a Proposed Technique for Reducing the Procurement of Airlift*, R-1604-PR, December 1974.

Landi, D. M., and F. J. Morgan, *Airlift Augmentation Alternatives: Briefing for the Secretary of the Air Force* (U), December 1974 (Secret), unpublished working paper.

Morgan, F. J., J. W. Higgins, D. C. Gogerty, and A. A. Barbour, *Airlift Augmentation for NATO Reinforcement* (U), October 1974 (Secret), unpublished working paper.

Landi, D. M., J. H. Hayes, J. W. Higgins, and F. J. Morgan, *Augmenting Strategic Airlift: A First Look* (U), December 1973 (Secret), unpublished working paper.

Publications on NATO reinforcement, and tradeoffs among forces in being, prepositioning, airpower, and surface transport include:

Emerson, D. E., and L. E. Catlett, *Improving Future NATO Capabilities for Defending Against a Major Conventional Warsaw Pact Attack: A Total Force Posture Analysis* (U), R-1240-PR, July 1973 (Secret).

Emerson, D. E., *Comparison of Alternative 1980 NATO Land and Air Forces: Methods and Results* (U), R-1243-PR, June 1973 (Secret).

Emerson, D. E., *Performance of Alternative ASW Forces for Command Protection* (U), R-1244-PR, June 1973 (Secret).

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A partial listing of recent Rand research on tactical airpower contributions to the defense of NATO includes:

Ellis, J. W., D. V. Palmer, and A. H. Peterson, *Campaign Comparison of Equal-Cost Close Air Support Aircraft Systems: A-10A, A-7, Derivatives, and A-4M* (U), R-1546-PR, November 1974 (Secret).

Ellis, J. W., D. V. Palmer, and A. H. Peterson, *Comparing the Capability of Close Air Support Systems in Air/Ground Campaigns* (U), R-1547-PR, November 1974 (Secret).

Dadant, P. M., E. Dews, F. Kozaczka, J. K. Seavers, J. A. Wilson, and R. W. Wise, *Tactical Airpower in a Mid-Seventies NATO Defensive Contingency (NATO Alpha)* (U), R-1192-PR, October 1974 (Secret).

Dadant, P. M., *Findings from Rand Studies of General Purpose Forces: A Briefing* (U), R-1460-PR, June 1974 (Secret).

Dadant, P. M., E. Dews, J. W. Higgins, F. Kozaczka, J. K. Seavers, and R. A. Wise, *Tactical Airpower in Two Mid-Seventies NATO Contingencies: Summary Report* (U), R-1191-PR, June 1974 (Secret).

Harris, K., and L. W. Wegner, *Tactical Airpower in NATO Contingencies: A Joint Air-Battle/Ground-Battle Model (TALLY/TOTEM)*, R-1194-PR, May 1974.

Dadant, P. M., E. Dews, T. E. Greene, J. W. Higgins, F. Kozaczka, A. H. Peterson, and R. A. Wise, *Tactical Airpower in a Mid-Seventies NATO Offensive Contingency (NATO Beta)* (U), R-1193-PR, May 1974 (Secret).

Huschke, R. E., *Tactical Airpower in NATO Contingencies--Modeling Weather Constraints on Air Operations: Weather and Warplanes IV* (U), R-1195-PR, January 1974 (Confidential).

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## EXECUTIVE SUMMARY

This report addresses an interconnected set of issues affecting strategic mobility: the capacity of the United States to move substantial combat ready forces quickly to distant parts of the world in time of crisis. Although a great many demanding scenarios have been and can be constructed that strain that capacity in various ways, the timely reinforcement of NATO by Army and Air Force combat units is generally considered to be a baseline requirement. If it can be satisfied, it will provide a capability adequate to serve most other conceivable needs. For that reason, and because the NATO-reinforcement scenario has most often been used by analysts to test the effectiveness of different modes of strategic mobility, it has also been used here. It is assumed, therefore, that a capacity to insure early reinforcement of U.S. forces on the NATO Central Front in time of crisis will be critical to deterrence of an attack by the Warsaw Pact and, should deterrence fail, to NATO's ability to repel any such attack.

The vast bulk of U.S. personnel and materiel that would be called upon to support U.S. forces in Europe ordinarily remain in the Continental United States. Moving troops and support personnel presents no special problem; the passenger capacity of the U.S. civil airline fleet is sufficient to ensure that people, their personal equipment, and many of their immediately needed supplies can be delivered to Europe quickly enough to satisfy mobilization plans. Materiel is quite another problem. Between 500,000 and 750,000 tons of major equipment (exclusive of "bulk," which can be accommodated in the holds of civil air transports) must either accompany the troops, be awaiting their arrival, or reach them shortly after. Without combat equipment, neither deterrent effect nor combat effectiveness survives.

Matching up reinforcement troops and equipment can conceivably be assured solely by prepositioning, solely by sealift, or solely by airlift of the essential combat and support equipment. In practice, some combination of those three modes will be used. Timeliness, however, dictates a heavy reliance on strategic airlift, which as currently composed

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cannot fully satisfy the requirements likely to be levied on it. This study explores the reasons for that reliance and examines the costs and benefits of several options for enhancing the present and future capability of strategic airlift forces.

(U) A major thesis underlying all the analysis of airlift enhancement in this report is that DoD should plan to move early reinforcements entirely by air, with sealift initially supporting only the (substantial) resupply requirements of the deployed combat forces. The rationale for this view includes the secular decline in number and suitability of available U.S. and NATO shipping, the time-consuming nature of convoy assembly and crossing, and the anti-shipping threat to early conveying posed by Soviet forces. These factors argue for initially deploying both men and equipment by air, limiting the early sealift role to resupply. As conveying becomes less risky over a period of weeks to months, additional equipment can be sent by sea.

(S) Prepositioning of equipment in the theater is one way of reducing the burden of both airlift and sealift. Much of the unit combat equipment for 2-2/3 U.S. divisions is nominally prepositioned<sup>1</sup> in NATO, but there are serious shortages of critical items. Prepositioning has its limits: It is inflexible; buying duplicate division sets, one for U.S. training and use and one for prepositioning, is expensive; concentrations of equipment in storage may be subject to preemptive attack; for some items, airlift (by suitably modified jets in the U.S. Civil Reserve Airlift Fleet--CRAF) is a more cost-effective deployment technique than prepositioning; and the effectiveness of prepositioning in the past has been degraded by storage and maintainability difficulties and the extensive work required to break out the prepositioned equipment and make it ready. Nevertheless, some additional prepositioning is likely in the long term, although its scope remains uncertain.

(U) Future airlift requirements planning must include the premise that early reliable sealift and additional large-scale prepositioning may not be feasible. Should that premise be in error, the consequence

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<sup>1</sup>(S) But much of the divisional support equipment, which includes such indispensable combat elements as tank companies and non-divisional artillery, is not.

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would be the enhancement of strategic mobility and the prospect of more rapid deployment. But airlift forces sized only to support sealift could be inadequate to NATO needs if sealift were not reliably available. A similar shortfall could occur if the capacity of the airlift force were to be tailored to augment prepositioning plans that had not been fully carried out.

In terms of transportability by air, Army equipment can be categorized as *bulk* (707 class), *oversize* (C-141A class),<sup>1</sup> or *outside* (C-5A class).<sup>2</sup> Each type of Army division (armored, mechanized, infantry, etc.) has its own special mix of equipment; thus, a different mix of C-5As, C-141As, and civil aircraft is needed to minimize deployment times for each division type, subject to Army constraints (called *unit integrity*) on the *order* in which unit equipment is moved. An airlift force planned as an adjunct to sealift will emphasize oversize capability. Sealift can carry outside as readily as oversize, and the aircraft capable of carrying oversize are cheaper and more widely available than those that can handle outside. But if sealift were unavailable, that airlift force would have insufficient outside capacity, and either unit integrity could not be maintained or much of the oversize capacity would become redundant. Deployment times would suffer in either case. No "excess" of outside can occur because outside-capable aircraft can, by definition, carry oversize equipment, insuring unit integrity.

## GROUND RULES AND ASSUMPTIONS

A number of study assumptions and ground rules are reviewed that are used in the analysis of deployment rates. They include:

- o The Army to be moved entirely by air consists of eight Army division equivalent maneuver units,<sup>3</sup> including initial support increments (ISI) for the divisions.

<sup>1</sup>E.g., trucks, trailers, vans, armored personnel carriers, jeeps.

<sup>2</sup>E.g., medium and heavy tanks, self-propelled artillery, some helicopters, combat engineer equipment, and large trucks and semi-trailers.

<sup>3</sup>This does not include the 2-2/3 divisions whose combat equipment (but not ISI equipment) is largely prepositioned; existing

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- o The equipment to be moved is a Rand-developed projection of elements of the 16-division "Abrams Army" as planned for FY 1982.
- o In addition to the Army equipment, equipment to support 54 Tac Air squadrons scheduled for deployment to NATO must be moved by air.
- o No additional prepositioning is assumed except as noted in special excursions.
- o Aerial refueling of C-5As and use of C-130s to augment strategic airlift are not considered in basic scenarios (but a brief evaluation of the effect of assuming aerial refueling is provided).
- o Unit integrity is maintained only at the division or brigade level, as appropriate to the unit being moved.
- o Movements assumed to be feasible and timely in studies done elsewhere (and therefore not modeled here) include: troops and bulk cargo (by the present CRAF fleet); resupply (by sea-lift and by the current narrow-body CRAF); and Army sustaining support increments (by sealift).
- o No terminal handling problems or enroute traffic problems are considered.
- o No adverse weather constraints and no airlift attrition (accidental or hostile) are considered.
- o Army and Military Airlift Command (MAC) readiness and performance parameters are assumed to conform to established planning factors, and all support and ancillary requirements to meet those planning factors are assumed to be available (e.g., maintenance personnel, fuel, spares).

A fundamental question for planning increases in airlift forces is, how rapidly must ground forces be capable of deployment? Guidance by the Secretary of Defense reveals only a notional criterion of a division a week;<sup>1</sup> war-gaming combat outcomes and military judgments suggest this is more nearly a minimum than a maximum requirement. Therefore, a method is developed for evaluating closure rates for the

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shortfalls in prepositioned equipment are scheduled to be eliminated by FY 1972.

<sup>1</sup>The criterion is loosely defined, since divisions differ markedly in both total weight and percentage of outsize equipment.

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specified eight division equivalent force. The contribution to more rapid closure of *each* aircraft enhancement option and of the cumulative effect of combinations of the options is analyzed. A cost-effectiveness measure of merit--the incremental cost for each day of decreased closure--is then applied to each airlift enhancement option considered.

(S) The base case considers the capability of the current organic airlift force--the 70 unit equipment (UE) C-5As and 234 UE C-141As--operating at present planning factor rates of ten hours per day for the first 45 days and eight hours per day thereafter. This airlift force can move the eight division equivalents plus ISIs (plus Tac Air equipment) from present widely dispersed CONUS locations to NATO in 121 days, roughly a division every 15 days.

## ENHANCEMENT OPTIONS

(U) Three basic enhancement options (and their approximate costs) being considered by the Air Force as of late 1975 are:

1. Modification of up to 110 wide-body commercial aircraft for CRAF to make them capable of carrying oversize equipment (\$850 million).
2. Building plugs into the fuselages of existing C-141A aircraft, increasing their volume by one-third, resulting in a 25 to 30 percent increase in the effective throughput of oversize equipment (\$550 million).<sup>1</sup>
3. Increasing spares, maintenance resources, and crew ratios sufficiently to support a 25 percent increase in the utilization rate of both C-141A (oversize) and C-5A (outsize) aircraft (\$1,250 million ten-year cost).<sup>2</sup>

(U) In addition to these three basic enhancement options, the Air Force is planning to acquire at least 41 UE advanced tanker cargo

<sup>1</sup>(U) The program costs of \$676 million are reduced here by \$126 million, representing our estimate of the cost for refueling and aerodynamic cleanup portions of the program.

<sup>2</sup>(U) A shorthand designation, the *increased UTE rate*, is used hereafter; it could be carried out separately on either the C-141A (\$780 million) or C-5A (\$470 million).

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aircraft (ATCA, modified 747 or DC-10 aircraft) at a cost of \$3.1 billion. They would operate chiefly as tankers but optionally as transports with a limited oversize cargo capability. Another \$1.3 billion program has been used for wing rebuilding to extend the service life of the C-5A. Although, strictly defined, that is not an airlift enhancement measure, it is generally considered to be an element of the composite program and will, in all, cost more than \$6 billion.

(U) Table S-1 presents values of the measure of merit for the three basic enhancement options (the Air Force's requested program, except for increased C-5A utilization rates), each considered *individually* as an add-on to the base capability and then summed to show their collective effect.

(S) Table S-1

## INDIVIDUAL CONTRIBUTION OF EACH ENHANCEMENT OPTION TO DEPLOYMENT OF FY 1982 ARMY (U)

Case Description	Closure Days	Closure Decrease (Δ)	Cost (\$ million)	Cost (\$ million/ Δ day)
Base case: organic force	121	--	--	--
Add CRAF (38 required)	93	28	425 <sup>a</sup>	15.2
(or)				
Add C-141 stretch	107	14	550	39.3
(or)				
Add increased UTE rate on C-141A	107	14	780	55.7
Add all three options (13 CRAF required)	93	28	1,755 <sup>a</sup>	62.7

<sup>a</sup>Only 1/2 of CRAF program costs included because of limited numbers required.

(S) Several points are clarified by the table. First, deployment of the FY 1982 Army is heavily outsize-constrained; only 38

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oversize-capable CRAF mods<sup>1</sup> need to be added to the existing C-141As (oversize) to balance the outsize capacity of the C-5As, which thereafter constrains the time of deployment to a minimum of 93 days. Using more than 38 CRAF would not contribute to more rapid deployment, given Army unit integrity constraints; at best they would provide additional capacity to move the Air Force equipment somewhat more rapidly, enhance resupply capacity, or provide more flexibility to airlift schedulers. Second, of the several oversize enhancements available, CRAF mods are clearly the cost-effective choice. They produce more rapid closure than either C-141A enhancement option, and they do so more cheaply by a factor of 3 to 4. Third, the last line of the table shows that exercising the less cost-effective C-141A options does not promote more rapid closure, it merely results in the displacement of CRAF mods. If the C-141A enhancements are undertaken, only 13 (rather than 38) CRAF mods are required to maintain unit integrity. Finally, although not displayed in the table, an ATCA used in a cargo-carrying mode would add additional, redundant, oversize capacity. Should the chosen ATCA be a 747 (rather than a DC-10), its capability would essentially equate to that of the CRAF mods, so that the 41-UE planned ATCA buy, if used in the cargo mode, would itself provide more than enough oversize capacity to balance available outsize capacity. Given its estimated costs, the acquisition of ATCA as an oversize cargo carrier would be less cost-effective than any of the other options.

(S) Table S-2 displays the outcome for two cases in which it is assumed that the UTE rate increase has been effective for the C-5A (the only planned outsize capacity augmentation), uncreasing capacity by some 25 percent. Closure of the force is now more rapid than for any of the cases in Table S-1 because outsize equipment is always the constraining factor. The CRAF mods program alone can still provide all the needed oversize to balance the enhanced outsize lift and still represent the cost-effective solution, again by a substantial margin. The net effect of buying 110 CRAF mods, the C-141A stretch and UTE rate

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<sup>1</sup>(U) Notional CRAF mods containing both the "mini-mod" nose door and the "full-mod" strengthened floor are assumed. In this report, they are called "maxi-mods."

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increase, and a cargo-mode ATCA would be to create a grossly redundant oversize capability for deployments by air, given the limited capacity of the present C-5A force even with the UTE-rate increment.

(S) Table S-2

## CONTRIBUTION OF ENHANCEMENTS INCLUDING INCREASED C-5A UTE RATE TO DEPLOYMENT OF FY 1982 ARMY (U)

Case Description	Closure Days	Closure Decrease (Δ)	Cost (\$ million)	Cost (\$ million/ Δ day)
Base case	121			
70 UE C-5A with Δ UTE; 234 UE C-141 with stretch and Δ UTE; CRAF (33 required)	72	49	2,225 <sup>a</sup>	45.4
70 UE C-5A with Δ UTE; 234 UE C-141A; CRAFT (60 required)	72	49	1,320 <sup>b</sup>	26.9

<sup>a</sup>Includes 1/2 of CRAF program (42 aircraft) costs.

<sup>b</sup>Includes full CRAF program (85 aircraft) costs.

### ARE CLOSURE RATES ADEQUATE?

(S) None of the combinations of options thus far considered can close the eight division force at a rate anywhere near a division a week. Moreover, since the 1982 Army modeled here is a not unreasonable representation of those forces to be stationed in the United States (without prepositioned equipment in theater) and designed for early reinforcement of NATO's fighting strength, it is likely that the desired closure time for those forces would be within 30 days of the outbreak of hostilities (D+30, in military terminology). Conventional scenarios assume that actual conflict will be preceded by a period of warning and mobilization and that U.S. and NATO mobilization will begin about a week after mobilization by Warsaw Pact forces begins. However, if the 93 (or 72) day minimum closure times shown in the preceding tables are taken at face value, closure by D+30 would imply that 63 (or 42) days will

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be available for U.S. mobilization in advance of hostilities. The arithmetic thus implies that Pact mobilization will continue for seven to ten weeks before an attack. These implied scenarios are somewhat less than credible; mobilization as extensive as that would indicate massive Warsaw Pact buildup, including substantial reinforcement from the Western Military District of the Soviet Union. In that case, U.S. mobilization and reinforcement aims would no doubt be much larger than the eight divisions analyzed here. Moreover, such long periods of mobilization would provide reasonably adequate time for sealift to be organized and functioning, so that neither the size nor the mix of airlift capabilities need be of great concern.

(S) Closure times for the 1982 Army--without reliance on sealift--can be decreased only through some combination of stationing more forces in NATO, prepositioning more unit equipment, and adding airlift capacity (especially outsize capacity). Increasing the number of U.S. units in Europe runs against the grain of many current trends: Mutual Balanced Force Reduction talks aimed at reducing stationed forces, the costs and foreign exchange drain of stationed forces, and the current Congressional and general public attitudes (to mention only three). Additional prepositioning of complete combat unit equipment sets in quantities greater than are currently programmed for the 1982 Army is probably infeasible before 1982. There are significant shortfalls of major combat items of equipment in the present prepositioned stocks and, in the interim, realization of the "1982 Army" by 1982 implies the production of divisional equipment to outfit the three new Abrams Army divisions, to upgrade two divisions from infantry to mechanized status, and to preposition the full unit equipment for one more mechanized division--in addition to making up the current shortfalls of prepositioned stocks.

(S) The production task is so large that it may not be possible even as planned. An earlier phase of this study indicated that replenishing currently prepositioned equipment from stocks in this country would completely occupy the present airlift force for some 30-40 days. Closure times for the Army would be correspondingly lengthened if such shortfalls still existed in 1982.

(S) A further problem for reduced deployment times is in 1982

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the Air Force plans to begin the serial modification of C-5As to correct the wing fatigue problem. At any time from 1982 through 1986, 12 C-5A aircraft will be in modification, which implies a maximum available UE of 58 C-5As. If the planned 25 percent increase in C-5A capacity provided by an increased UTE rate affects only the *then-available* C-5As, the aggregate capability will be about that of 70 UE C-5As operating without the increased UTE rate. At least for the 1983-86 time period, deployment of the 1982 Army by air is more likely to require 93 than 72 days, *if* prepositioning shortages are eliminated.

## MORE RAPID DEPLOYMENT BY AIR

(U) There is increasing concern about a class of NATO-Warsaw Pact confrontations involving short mobilization times and initial conflict using largely in-place forces. "Sudden attack" and "short warning attack" are two widely used generic descriptors of this scenario. "Short warning" attack cases obviously impose stringent requirements on deployment rates and strategic airlift capabilities. For such cases, the *prompt* availability of substantial sealift is doubtful, whatever sealift is immediately available would hardly be able to make a successful transit before hostilities begin, and few convoys are likely to arrive during the first 30 days after fighting begins. Clearly, this scenario puts a premium on capabilities for rapid, balanced deployment by air.

(U) Only a substantial augmentation of airlift capabilities, both outsize and oversize, can offer the prospect of meeting the stringent closure requirements inherent in "short warning" scenarios. Table S-3 summarizes the outcomes for forces containing nominally twice the current outsize capacity plus substantial CRAF modification programs, in conjunction with the current C-141A force.

(S) The various airlift forces identified in the table could in principle close the eight division force by D+30, given mobilization times no longer than 11-21 days prior to the outbreak of hostilities. In addition, given only 3-10 days of mobilization, by D+30 they can close all but the last two divisions (an airmobile and an airborne division) and their two collocated reserve brigades. Since those units

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(S) Table S-3

## DEPLOYMENT OUTCOMES FOR "DOUBLE THE OUTSIZE" PLUS CRAF--1982 ARMY AS PLANNED (U)

Description	Days to Closure	
	Without Δ UTE on C-5s	With Δ UTE on C-5s
140 C-5; 234 C-141A; 85 CRAF	51	46
140 C-5; 234 C-141A; 100 CRAF	48	43
140 C-5; 234 C-141A; 115 CRAF	45	41

are less suited than others to deal with heavily armored Warsaw Pact forces, this slippage of closure may be tolerable. In any event, initial dependence on sealift would be significantly lessened.

(U) The more rapid closure times require a large number of CRAF mods;<sup>1</sup> thus far U.S. airlines have offered only 85 of their 747s; the original program objective was to enroll 100. Acquiring as many as 115 CRAF mods would probably require participation in the modification program by our NATO allies, whose civil air fleets include more than enough 747s to make up the difference. Alternatively, if the ATCA is procured in its currently envisioned oversize-only configuration, some part of the deficit could be made up by using it in the cargo rather than the tanker mode.

(U) In the near term, the only way to obtain additional oversize capacity equivalent to 70 more C-5As is to purchase some major modification derivative of the 747 or the C-5. Either represents a one-for-one C-5 equivalent.<sup>2</sup> If the oversize-capable derivative also had a refueling capability, the tanker part of the ATCA role could be

<sup>1</sup>(U) All assumed in the analysis to be Boeing 747 maxi-mods; there are currently about 15 747s in service with U.S. airlines that are freighter or cargo-capable modifications.

<sup>2</sup>(U) The Air Force has estimated the cost of an oversize-capacity ATCA at \$65 million apiece (in then-year dollars).

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partially satisfied, and the resulting equal-cost force would more nearly approximate the balance of outsize and oversize capabilities necessary for deployment without sealift than would the Air Force's requested force.

(U) Both 747 and C-5 derivatives have advantages and disadvantages. The 747 has better range, payload, spares availability, and maintainability characteristics than the C-5, but its low-wing design makes it less flexible in loading and unloading. The cockpit would have to be raised to accommodate an outsize-capable door and increased vertical clearance near the nose, and even then the loading "cube" would be less flexible than that of the C-5A.

(S) Although the rapid modification and introduction of either a 747 or C-5 derivative conceivably provides a near-term solution to the outsize problem, without a risky concurrent development and production program additional capacity enhancement before about 1984 is doubtful. "Double the outsize" could be available by about 1987 if the program began by 1979, if aircraft were produced at a rate of two per month, and if no major problems developed. In view of the scheduled drawdown of available C-5A aircraft between 1982 and 1986, a critical shortfall of airlift deployment capacity seems likely during that period.

(U) An alternative to modifying a 1960s technology aircraft is to design a new, larger, and more efficient transport that would offer lower life-cycle costs and major improvements in engines, structures, and aerodynamics. A civil development that could also be used for military airlift is unlikely to be economically feasible before the 1990s unless heavily subsidized by the federal government. But if a new outsize aircraft with both civil and military uses should be developed, it might be available as a replacement for the C-5As when they begin to reach the end of their economically useful life toward the end of this century.

(U) The 1982-86 outsize shortfall and the prospective emergence in the 1990s of a new-technology cargo aircraft together raise questions about the remaining life of the C-5A and options for extending that life

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and their costs. The service life limit for the C-5A aircraft is set by the Air Force at 8,000 fatigue equivalent flight hours (based on 1974 aircraft configuration and 1973 operational use). As of 1976, the fleet average accumulation was about 4,000 hours, or nearly halfway to the limit in only about five calendar years of operation. The original design goal was 30,000 flight hours of more severe operational use than that of 1973, which reflected some limits on current operations to conserve remaining life. The structural deficiencies of the wing led to the development of the original Option H plan (requiring the replacement of the lower surface panels in some of the wing boxes), which was approved by the Secretary of the Air Force in 1973. Option H has since evolved to include the full replacement of all of the wing boxes, an expedient intended to ensure that the wing would be capable of sustaining 30,000 flying hours in severe use. The 1973 Middle East war, the subsequent oil embargo, and the eventual quadrupling of the price of aviation fuel brought on reductions in peacetime use of all Air Force aircraft, especially of large aircraft. Although the original plan for the C-5A envisioned flying each aircraft about 1,800 hours per year on the average (the 30,000-hour design life corresponds to about 17 calendar years of service), MAC's current peacetime operating plans envision about 700 hours per year on the average<sup>1</sup> to maintain 4.0 flight crews per UE. Thus, if Option H restores no more than 22,000 additional flying hours (to bring *total* use to 30,000 hours), MAC's planned UTE rate implies retention of the C-5A in the active inventory at least until the decade 2010-2020 (assuming no extra utilization for contingencies). If, as expected based on current use, the wing will provide more than 30,000 equivalent additional hours, the notional retention date would be further extended.<sup>2</sup> Such a long period of use might be reasonable if the C-5A were economical to operate and maintain and not

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<sup>1</sup>After the wing modification, MAC expects an average UTE rate of 2.13 hr/day (360 day year) for each of the 70 UE aircraft. This is equivalent to 697 hr/yr/aircraft based on all 77 aircraft.

<sup>2</sup>However, at some point, a high-cost modification/maintenance program would presumably be required to control corrosion and fatigue in other structural areas.

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subject to technological obsolescence. If that is not the case, the Air Force could usefully review the 1973 decision that a service life of 30,000 hours should remain the design goal for fixes to the C-5A wing. Option H represents a high-confidence but expensive way to meet this design goal. Lesser options involving more modest structural modifications and extending present constraints on operational use conceivably could extend the service life of the C-5A through the balance of this century for significantly less than Option H will cost, and could avoid the critical reduction of outsize capacity during 1983-86.

Assessments of airframe fatigue problems of the C-5A and other Air Force aircraft are currently being performed using crack growth calculations based on the scientific theories of fracture mechanics. Until recently, service use limitations had been established by the wholly empirical correlations that underlie the classical fatigue methods. The advantage of the fracture mechanics approach is that, in addition to estimates of time to failure, it provides a rational theoretical basis for the assessment of the critical crack length at which an element will fail. Both approaches rely on test data to assess the validity of the assumptions and procedures that are followed in any given application. However, it is agreed that the calculated 8000-hour safe service life is as yet subject to considerable uncertainty and that empirical evidence accumulated to date is insufficient to confirm or refute the precision of that calculation.<sup>1</sup> Nor are data available to support confident estimates of the benefits and costs of lesser modifications.

Increases of several thousand hours in the service limit can extend the average service life of the C-5A force at least into the 1990s. The effects of various service life extensions are shown in Fig. S.1, which relates utilization rates and peacetime operational limitations of differing stringencies to the calendar time to which the forcewide average service life could be extended (without further

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<sup>1</sup>One question about the forthcoming fatigue problems with the current C-5A wing is whether it is possible to wait for the appearance of cracks in service aircraft (e.g., reinstitute higher UTE rates for the lead-the-force aircraft) before making the final commitment to modification.

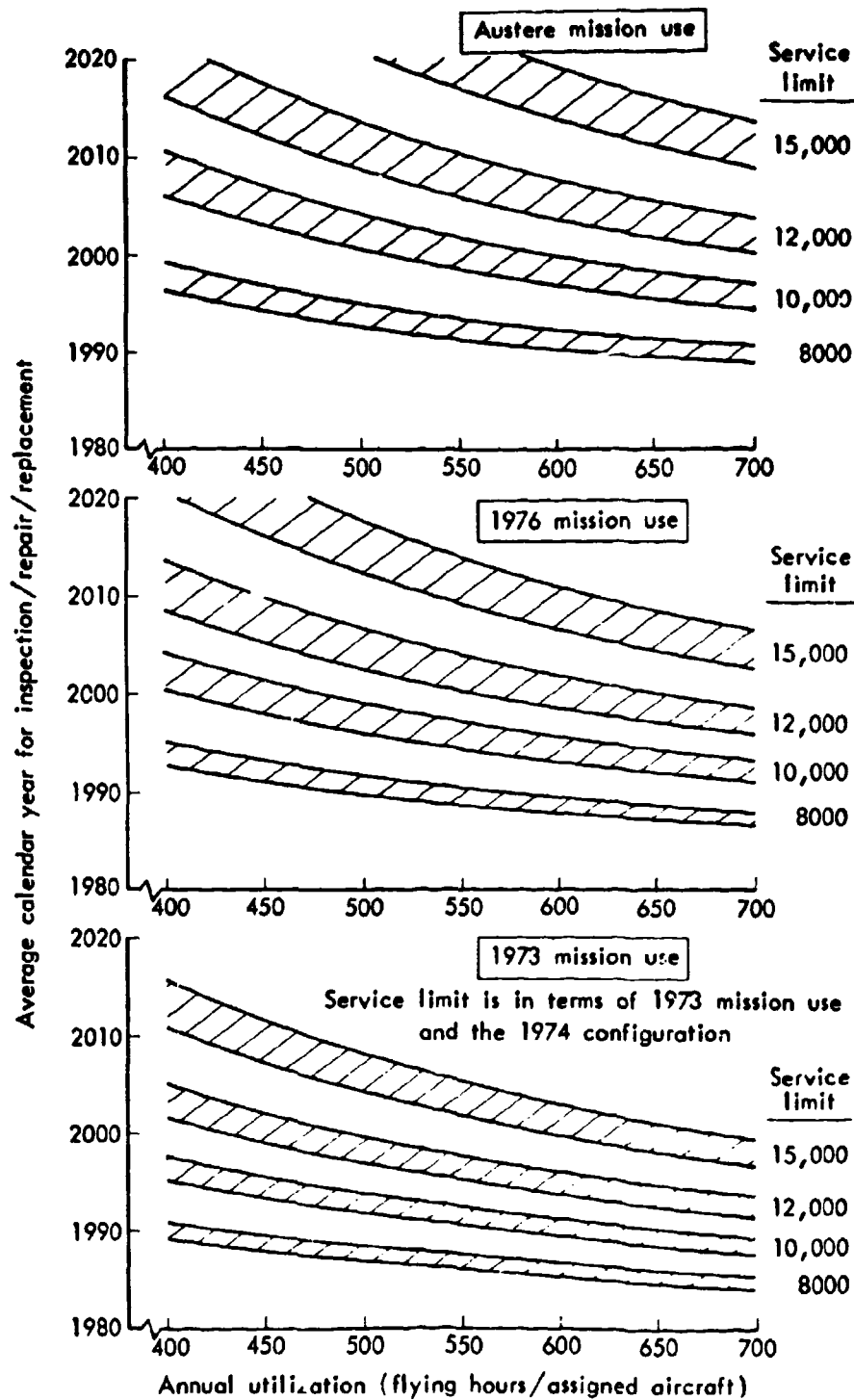


Fig. S.1 — Sensitivity of calendar year service to mission use, service limit, ALDCS life extension effectiveness (shaded area) and annual utilization

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modification). Because the C-5A could become technically or economically obsolete by the turn of the century, an immediate effort is warranted to determine how it might be made to last that long without the expense of Option H modifications. Technical activities and empirical testing to that end can and should be undertaken over the next year or two. The results would permit more confident assessment of service life limits and lesser cost modification alternatives. Promising initiatives encompass (1) resolution of the effectiveness of the active lift distribution control system (ALDCS) in reducing stress at critical locations, (2) tests to determine the initial flaw distributions, (3) reassessment of the onset of general area cracking and verification of the operational stress experience, (4) adjacent panel residual strength tests, and (5) evaluation of the need for additional full-scale fatigue testing. A desirable first step is the formation of a new high-level review group to develop detailed test plans, evaluate new information, and provide alternative sources of action to top-level Air Force decisionmakers.

Two alternatives--no modification and Option H--represent the end points of a spectrum of service life management actions for the C-5A. If some greater life extension were required than might be obtained through austere use of the remaining service life in the current C-5A force, or if an extended period of such austere use were deemed infeasible, at least two other options might provide lesser service life extensions than Option H but at much lower cost. A modest fastener change program might provide several thousand more hours at one-fourth to one-fifth the cost of Option H (if disassembly of the wing boxes can be avoided), and a rework of the current configuration of the wing could more than double the present service life estimate at a cost lower than that of Option H. Both modifications would extend service life into the next century, even with 1973 operational use and an increased UTE rate, with a margin for contingency or wartime use. Evaluation of the fastener change option is urgent; to be effective it may have to be undertaken before the 8000-hour point occurs.

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## OPTIONS, STRATEGIES, AND HARD CHOICES

The Air Force's current programs are compared with a sequential decisionmaking strategy designed to minimize the cost of moving to a future balanced capability. The most serious problems with the current enhancement program are:

- o The major commitment to oversize capacity expansion of airlift forces will leave deployment capabilities strongly dependent on the timely availability of reliable sealift for the foreseeable future;
- o A severe future shortfall of outsize capacity will develop, relative to available oversize, under *any* scenario that requires rapid deployment of ground forces entirely by air;
- o The earliest expenditures are invested in the least cost-effective oversize enhancement options--the C-141A stretch and increased UTE rate;
- o The prospective near-term expenditure of some \$6 billion for the C-141A stretch, the UTE rate increase, CRAF mods, ATCA, and the C-5A Option H may limit or foreclose additional funding to acquire the needed outsize capacity increase;
- o A commitment to Option H mod for either part or all of the C-5A force may not be necessary if additional test and analysis confirm that:
  1. The C-5A's service life can be made to extend to the 1990s at minimal cost, or
  2. Other, lower-cost options could lead to further extension if necessary.

## THE INCREMENTAL DECISION STRATEGY

The objectives of an incremental approach are to trade time for money, proceeding only with clearly indispensable programs, to use some of the withheld money to resolve crucial uncertainties, and to commit additional funds later to those programs that then appear most likely to provide enduring airlift enhancement.

There are few clearly indispensable programs at this point:

- o A CRAF modification program, with renewed emphasis on the maxi-mod;

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- o Continued, even accelerated, acquisition of the spares necessary to support at least the currently planned utilization rates of ten hr/day for the first 45 days and eight hr/day thereafter;
- o Early design of a fastener change modification along with increased technical analysis of the severity of the C-5A wing problem;
- o Continuation of the design, fabrication, and testing of Option H as planned, with no commitment to production;
- o A prompt start on a design competition, possibly including prototyping, to demonstrate the feasibility and technical capabilities of an outsize ATCA.

Table S-4 displays the principal cost implications of the two approaches. The upper portion of the table recapitulates the cost of the enhancements (other than the CRAF mod program) currently requested by the Air Force. The balance of the table sums up generously estimated notional allocations for the near-term actions and items identified as elements of the incremental decisionmaking process suggested above. It includes two potential follow-on programs, an outsize ATCA buy and a range of prospective C-5A fixes.

The base cost of CRAF mod programs remains uncertain. But as they are an element of both the Air Force request and the incremental strategy, Table S-4 includes an estimate of the incremental cost that might be incurred if only maxi-mods were ordered, rather than the mix of mini-mod and full-mod aircraft now contemplated. The estimated incremental cost is \$1 million per aircraft for a total of \$85 million. Similarly, the incremental strategy provides an allocation of \$100 million from the planned FY 1980-81 spares buy to support currently authorized utilization rates. The design of outsize ATCAs based on C-5A and 747 derivations is estimated to cost no more than \$500 million, adequate to provide for prototyping should that be judged necessary.

The lack of precision in such estimates and the incompleteness of the cost analysis limit the uses to which the table may be put. Nevertheless, it suggests that the incremental strategy does not necessarily lead to significantly higher outlays than the Air Force's currently requested programs, even with generous estimates of the costs of

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Table S-4

## COST COMPARISONS OF AIR FORCE AND INCREMENTAL STRATEGIES

Program Description		Costs, \$ Millions			
<u>Air Force Requested Programs</u>					
C-141 stretch		550			
C-141 increased UTE rate		780			
C-5A increased UTE rate		470			
Option H kit production and installation		1,126			
ATCA	(41 UE)	<u>3,100</u>	(91 UE)	<u>5,900</u>	
Total:		6,026		8,826	
<u>Illustrative Incremental Strategy</u>					
CRAF maxi-mods incremental		85			
C-5A testing and option enhancement		100			
Spares to support 10/8 UTE		100			
Prototype outsize ATCA derivatives		500			
Acquisition 80 outsize ATCA (\$65 million per aircraft)		5,200			
Possible C-5A repairs (no mod)		0	(fastener change)	300	(Option H) 1,126
Total:		5,985		6,285	7,111

information enhancements to be undertaken in the interim. Proceeding with Air Force programs first and then embarking on a program to restore balanced airlift capabilities (by acquiring double the present outsize capacity) could nearly double the costs of either strategy.

In the NATO scenario, the principal role of the outsize ATCA would be to carry outsize equipment, not to refuel other airlifters. An outsize ATCA refueling a C-5A would produce some modest increase in C-5A utilization and in payload carried (preliminary calculations by the Air Force suggest an 8 to 24 percent improvement), but an outsize ATCA carrying outsize equipment accompanied by an unrefueled C-5A produces some two C-5 equivalents. The tanker capability of the ATCA is certain

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to have a high value for non-NATO contingencies that involve deployments of extended ranges with few (or no) enroute bases.

#### FUTURE CONSIDERATIONS AND FURTHER ANALYSES

Although uncertainties about the remaining life of the C-5A are of major importance in planning future airlift enhancements, they are by no means the only critical uncertainties that must be resolved. Other important points that could influence decisions about long-term airlift enhancement include:

- o Obtaining clearer OSD guidance on the primacy of airlift for early NATO reinforcement, on desired airlift capabilities, and on closure rates;
- o Evaluating the feasibility of an outsize version of ATCA and the interrelationships of tanker and airlift requirements in the post-1980 period;
- o Conducting detailed feasibility studies of potential capabilities, costs, and availabilities of both new and derivative outsize aircraft;
- o Undertaking more refined airlift enhancement studies over an extended time horizon, using appropriate assumptions about escalation and discounting, and comparing "balanced" capabilities over time;
- o Exploring with the Army ways to reduce both outsize and oversize equipment lists, thus moderating NATO contingency airlift requirements;
- o Evaluating with the Army the feasibility of *partial prepositioning*--prepositioning high-weight but low-cost items--duplicating only less-expensive items but reducing the initial demands on airlift.

Several issues that can influence CRAF mod program decisions could be resolved in the next two years or so:

- o Completion of the prototype mods and tests of their compatibility in loading Army oversize items to better understand loading, unloading, and handling problems;

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- o A more concerted Air Force effort to upgrade some of the airlines' offers of 747s from mini-mod to maxi-mod;
- o Efforts by DoD to insure participation of our NATO partners in the CRAF mod program;
- o Consideration of a legislative mandate to incorporate maxi-mod CRAFT capabilities in all new Boeing 747 aircraft at the time of manufacture.

In the same time frame, several uncertainties about the C-141A stretch program should be resolved:

- o Clarification of uncertainties about the remaining service life of the stretched aircraft;
- o More careful assessment of the benefits foreclosed by the stretch;
- o Operation of the prototype to discover the effect of the stretch on aircraft performance.

A number of conditions precedent to future higher crew ratios can also be satisfied in the interim:

- o Congressional authorization for the acquisition of the additional spares needed to support higher surge rates is needed before more crews can be utilized;
- o A detailed analysis of what factors first constrain the C-5A surge capability can be conducted;
- o Allowable and probable maximum wartime flying-hours for transport crews can be reviewed.

In conjunction with the resolution of uncertainties about the C-5A, the initiatives enumerated above would place the Air Force in a position to present to Congress a coherent program for the acquisition of balanced airlift forces. The dominant question remains: What mix of organic transport aircraft as additions to an indispensable widebody CRAF mod program must the Air Force have by the late 1980s to achieve the objective of early, rapid reinforcement of NATO? The key factor is that outsize-capable aircraft can always help move an excess of oversize

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equipment, but oversize-capable aircraft cannot transport an excess of outsize equipment.

THE FUNDAMENTAL ISSUE FOR STRATEGIC MOBILITY DECISIONMAKING

The above array of unanswered technical and operational questions is impressive; but for most, their resolution would only refine program decisions. The issue for policymakers is: Should the United States reduce the long-term critical dependence on sealift to deploy the Army, or should efforts be concentrated on making larger amounts of more capable sealift available much earlier than at present?

Current defense guidance and proposed programs do not address this issue; rather, they are a patchwork of improvements at the margin in both sealift and airlift. Moreover, the lack of policy focus leads to a lack of funding authorizations adequate to carry out either approach effectively. An emphasis on sealift would require many more vessels, better suited to rapid loading and transport of Army cargo, on immediate standby availability; more robust defense of both convoys and ports would also have to be provided. Airlift enhancements would be of low priority, given more reliable and timely sealift in quantity. Alternatively, a policy emphasis on airlift would require somewhat more oversize, for which redundant programs are proposed, and a lot more outsize capacity, for which no efforts are under way. Sealift would require little augmentation effort, since it is adequate to handle resupply tasks and contribute to later stages of extensive deployments.

Given that much of the problem of conventional defense of NATO is attributable to insufficient prior investment in combat equipment, the need for rapid and timely reinforcement is not likely to vanish, and the costs of stiffening NATO defenses will be substantial. It is doubtful that, in addition to those expenditures, the United States can afford to pursue adequate and timely reinforcement capabilities *both* by air *and* by sea. That course runs the risk of achieving only partial success in both areas, the sum of which would not enhance our confidence in our ability to conduct timely reinforcement.

The direction of the Air Force's current program implies a decision to rely on sealift. Oversize enhancements alone do little to

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reduce the current critical U.S. dependence on timely availability of sealift. At the logical extreme, even if *all* of the Army's oversize equipment could be deployed by air, the Army's outsize equipment--much of which constitutes the heavy firepower of maneuver units--could only be deployed slowly, at first limited by the available outsize airlift, and in larger quantities only after several weeks have elapsed, as sealift begins to arrive. But is "several weeks" timely enough?

No compelling case can be made for exercising all the oversize enhancement options while reserving judgment on how much and what kind of outsize aircraft to acquire when. The CRAF mod program alone provides more than sufficient oversize capacity to balance the available C-5A lift. More oversize than that simply runs up the ultimate airlift enhancement bill without mitigating all-airlift deployment problems, even in the short run.

A prompt start on outsize aircraft augmentation can set in motion the development of a future deployment capability that at least can significantly reduce the dependence on sealift for deployment of Army equipment and may substantially increase the rate of deployment of combat units in the critical early weeks of an unfolding crisis. If the objective is to reduce U.S. dependence on the timeliness of sealift, a lot more outsize airlift capacity is needed, even though the total increment cannot yet be defined precisely. Before making the current program decisions, the Department of Defense should decide whether to continue reliance on sealift or to begin an outsize aircraft augmentation.

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DEPARTMENT OF THE AIR FORCE  
11<sup>TH</sup> WING



29 May 2003

11 CS/SCS (MDR)  
1000 Air Force Pentagon  
Washington, DC 20330-1000

Rand  
ATTN: Mr. Richard Bancroft  
1700 Main Street  
PO Box 2138  
Santa Monica, CA 90407-2138

Dear Mr. Bancroft

Reference your letter, 18 February 2003 requesting a Mandatory Declassification Review for public release of the following documents:

Strategic Mobility Alternatives for the 1980s: Vol. 1, Executive Summary,  
R-1941/1-AF, March 1977


Strategic Mobility Alternatives for the 1980s: Vol. 2, Analysis and  
Conclusions, R-1941/2-AF, March 1977

The appropriate Air Force activity reviewed the subject documents in accordance with DOD 5200.1-R and Executive Order (EO) 12958 and recommend declassification of entire documents.

One copy of each document was retained in this office for future reference concerning this case.

Any questions regarding this review may be addressed by contacting the undersigned at (703) 696-7265, DSN: 426-7265 or e-mail joanne.mclean@bolling.af.mil. Please reference Air Force case # 03-MDR-025.

Sincerely

  
JOANNE MCLEAN  
Mandatory Declassification Review Manager

1 Attachment  
Records for Review, Documents  
# R-1941/1-AF and R-1941/2-AF,  
dated March 1977